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Original Article

Use of Dexmedetomidine as an Adjuvant to Ropivacaine in Supraclavicular Brachial Plexus Block for Patients Undergoing Upper Limb Surgery

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Abstract

Background

Various adjuvants have been added in Brachial plexus block but only few studies have reported the use of dexmedetomidine. Alpha 2 agonist Dexmedetomidine used as an adjuvant to the local anesthetic has been suggested to prolong the duration of peripheral nerve block. The objective of this study is to compare the effect adding Dexmedetomidine to Ropivacaine in Supraclavicular brachial plexus block

Materials and Methods

A Quantitative, comparative cross sectional prospective study was conducted in 78 patients randomly allocated into three groups. Group R received 30ml of 0.5% Ropivacaine, Group B received 30ml of 0.5% Ropivacaine + 50mcg of Dexmedetomidine for supraclavicular block and Group Y received 30ml of 0.5% Ropivacaine 0.5% for supraclavicular block and intravenous Dexmedetomidine 50mcg . The onset time to sensory and motor blockade, duration of sensory and motor block and duration of analgesia were recorded.

Results

The onset of Sensory block and motor block was earlier in group B than in group Y and group R. The duration of sensory block and motor block duration was also prolonged in group B when compared with group Y and group R. The duration of analgesia was significantly longer in group B, and group Y when compared to group R.

Conclusion

Dexmedetomidine as an adjuvant to Ropivacaine decreases the sensory as well as motor block onset time, prolongs sensory and motor block duration and also increases the duration of analgesia. The action of Dexmedetomidine most probably is local rather than centrally mediated.

Keywords: *Analgesia, Brachial plexus block, Dexmedetomidine, Ropivacaine*

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Introduction

Supraclavicular brachial plexus block is a commonly performed regional anesthesia technique for upper limb surgeries. Though local anesthesia provides adequate operative condition but have shorter duration of postoperative analgesia [1]. Alpha 2 adrenoceptor agonist, dexmedetomidine has been used efficaciously and safely as an adjuvant to local anesthetic agent in regional nerve block to prolong analgesia [2]. Ropivacaine is less arrhythmogenic, cardiotoxic and neurotoxic then commonly used local anesthetic drug bupivacaine [3].

Most of the clinical studies have reported the administration of dexmedetomidine in combination with bupivacaine and levobupivacaine but not with Ropivacaine [1]. The analgesic efficacy and clinical utilities of adding Dexmedetomidine to Ropivacaine in block are still to be learned [4].

In our study we aim to compare the efficacy of perineural and intravenous Dexmedetomidine with Ropivacaine in prolonging the onset of motor and sensory block, duration of motor and sensory block, analgesic duration for patient undergoing upper limb surgeries using ultrasound guided brachial plexus block.

Materials and Methods

After ethical committee approval and written informed consent, 78 American Society of Anesthesiologist (ASA) grade I or II patients aged between18-6 0 years, scheduled for elective upper limb surgery below mid-humerus level under supraclavicular brachial plexus block were enrolled in this Quantitative, comparative cross sectional prospective study. Preanesthetic assessment of all the patients was done the day before scheduled surgery. Patients were premedicated with tablet Clonazepam 0.25 mg and tablet ranitidine 150 mg on night before surgery and in the morning of day of surgery with a sip of water. Patients with preexisting peripheral neuropathy of upper limb, bleeding disorders, infection at injection site, untreated pneumotho-rax, patients on adrenoreceptor agonist or antagonist therapy, history of severe cardiac, respiratory, hepatic or renal disease, pregnancy, lactating mother and known hypersensitivity to the study drugs, were excluded from the study.

Using a probability sampling method, simple random technique using color code for selection like red, blue and yellow color was done. Depending upon the selection of color by patient they were divided into three groups of 26 patients each as: Sample Size estimation: Number of cases in each group (n) = 2[z (1- a /2) + z(1- b)] 2 / D2, where z(1- a /2) and z(1- b) represent percentage points of the normal distribution for statistical significance level and power respectively and D represents the standardized difference, on the basis of previous study by Kathuria S et al [4]. As standardized difference,)/S, So, = 0.899. Keeping the confidence interval at 95% and a power of 90%, z (1- a /2) = 1.96 and z (1- b) = 1.2816. Thereby, Number of cases in each group (n) = 2[z (1- a /2) + z (1- b)] 2 / D2 = 2[1.96 + 1.282] 2 / 0.8992 = 21.02/0.808 = 26.015. So, the sample size is at least 78, with 26 in each group.

Group R received 30 ml 0.5% Ropivacaine and 1 ml of Normal Saline (NS), Group B received 30 ml 0.5% Ropivacaine and 50mcg of dexmedetomidine diluted in 1ml NS and Group Y received 30ml of 0.5% ropivacaine with 1 ml NS and 50mcg of dexmedetomidine diluted in 15 ml NS administered as infusion over 15 over 15 min. After shifting the patient to operating table, standard anesthesia monitoring in the form of the baseline measurement of heart rate, noninvasive arterial blood pressure, and peripheral oxygen saturation (SpO2) was started. Intravenous access was achieved using 18 G cannula in the nonoperative arm. After aseptic preparation of the area, surpraclavicular brachial plexus block was performed under ultrasound guidance (Sonosite, M-Turbo Ultrasound system with high frequency (13 MHz) linear probe). Drug was administered according to the allocated group with repeated aspiration and incremental dosing. Intravenous infusion of 15ml (50 mcg of Dexmedetomidine) study drug (Group Y) was also started at the time of starting the block

Sensory block was assessed by pin prick test in the six nerve territories (Musculocutaneous nerve = Lateral side of forearm, radial nerve = Dorsum of the hand over the second metacarpophalangeal joint, median nerve = Thenar eminence, ulnar nerve = Hypothenar eminence, medial cutaneous nerve of arm = Medial side of the arm and medial cutaneous nerve of forearm = Medial side of the forearm) using a 3-point scale [4]. Grade 0 = normal sensation, Grade 1 = loss of sensation of pin prick (analgesia) Grade 2 = loss of sensation of touch (anesthesia). Motor block was evaluated by thumb abduction (radial nerve), thumb adduction (ulnar nerve), thumb opposition (median nerve) and flexion at the elbow (musculocutaneous nerve) using Bromage scale for upper extremity [5]. Grade 0 = Able to raise the extended arm to 90° for full 2 seconds. Grade 1 = Able to flex the elbow and move the fingers but unable to raise the extended arm. Grade 2 = Unable to flex the elbow but able to

move the fingers. Grade 3 = Unable to move the arm, elbow and fingers

Both sensory and motor blocks were assessed every 3 min till their onset and the time between administration of drug and onset of complete sensory and motor blockade was recorded. Sensory and motor blockade was then assessed every hour after the end of surgery until first 12 hours and thereafter every two hourly until the block completely wore off. Onset time of sensory blockade was defined as the time interval between the end of local anesthetic injection and loss of sensation to pin prick. Onset time of motor blockade was defined as the time interval between the end of local anesthetic injection and loss of movement in all the nerve distributions. Orthopedic upper limb surgeries were commenced after the onset of sensory and motor blocks. In any event of inadequate sensory or motor block after 30 min of injection of drug, the case was converted to general anaesthesia and was excluded from the study.

On arrival in recovery room patients were asked to rate their pain on 11 point visual analog scale (VAS) and thereafter pain was assessed regularly every 30 min for first 2 h and then every hourly till 24 h. Testing for sensory and motor block regression was done every 15 min until complete resolution. Duration of sensory block was defined as the time interval between the end of study drug administration and complete resolution of sensation on all nerves. Duration of motor block was defined as the time interval between the end of study drug administration and the recovery of complete motor power of the hand and forearm to pre-injection level. Injection Diclofenac sodium 75 mg intravenously was administered when VAS score was ≥4. The time between the end of local anesthetic administration and first rescue analgesic administration was recorded as the duration of analgesia.

Patients were asked about the side effects like nausea, vomiting, and skin rashes. They were also monitored for tachycardia (Heart Rate >20% of baseline value), bradycardia (Heart Rate 50 bpm), hypotension (Systolic Blood Pressure > 20% below baseline value), hypoxemia (Oxygen saturation 90%), and any other potential side effects like pneumothorax, horners syndrome, phrenic nerve palsy, or respiratory depression intraoperatively and postoperatively. The resulting data was then recorded. Hypotension was managed using 6mg bolus of intravenous mephentermine sulphate used in incremental doses. Bradycardia was managed by awakening the patient if the patient was asleep and if HR was still below 50 beats per minute then intravenous atropine sulphate 0.6 mg was administered.

Data collection was done in a preformed sheet and entered in Microsoft Excel. Statistical analysis was done by using statistical package for the social sciences (SPSS) software version 20.0 (SPSS Ltd, Chicago, IL, USA). Values are presented as mean ± standard deviation (SD) or frequency. Hemodynamic data were analyzed using t-test and Mann- Whitney U-test for group comparison. Nominal categorical data such as gender was also analyzed with Chi-square test. For all determination p-value < 0.05 (2-tailed) was considered as statistically significant.

Results

There was no difference among the patients in the three groups with respect to age, height, weight, BMI, sex ratio and the ASA physical status. [Table 1]

Table 1: Demodraphic data

Variable	Group R (%) Mean ± SD	Group B (%) Mean ± SD	Group Y (%) Mean ± SD
Age (years)	38.42 ± 8.54	40.96 ± 9.59	39 ± 8.3
BMI (kg m^{-2})	23.49 ± 2.38	25.07 ± 2.14	24.32 ± 2.39
Gender			
Male	13(30.23%)	16 (37.2%)	14 (32.5%)
Female	13 (37.1%)	10 (29.9%)	12 (34.5%)
ASA Grade			
I	16 (31.3%)	17 (33.3%)	18 (35.3%)
II	10 (37%)	9 (33.33%)	8 (29.6%)

The sensory and motor block onset was significantly quicker in group B than in group Y and group R. The mean sensory block onset time was 13.1 ± 2.9 min in group B as compared to 22.6 ± 5.6 min and 17.9 ± 4.1 min in group R and Y, respectively. The mean motor block onset time was 17.7 ± 3.5 min in group B when compared to 25.7 ± 5.1 min and 21.0 ± 4.6 min in group R and Y, respectively .

The duration of sensory as well as motor block was significantly prolonged in group B and group Y as compared to group R. The duration of sensory block was maximum in group B (733.9 ± 166.6 min) followed by group Y (645.0 ± 133.6 min) and group R (468.1 ± 104.8 min).

The duration of motor block was also maximum in group B (596.9 ± 149.3 min), followed by group Y (535.0 ± 124.1 min) and group R (401.6 ± 92.2 min). The duration of analgesia was significantly prolonged in group B (882.7 ± 164.2 min) and group Y (826.5 ± 158.6 min) when compared with group R (571.2 ± 119.6 min). [Table 2]

The duration of analgesia was comparable between groups B and Y. The total analgesic consumption in 24 h postoperatively was significantly higher in group R than group B and Y. However, the difference in total analgesic consumption between group B and Y was not statistically significant.

No episode of hypoxemia or respiratory depression during 24 h period postoperatively was seen in any patient. Bradycardia was observed in three patient belonging to group Y and one patient in group B intraoperatively that was treated with injection atropine sulfate 0.6 mg IV. Hypotension was observed in two patients in group Y and one patient in group B, which was effectively treated with incremental 6 mg IV boluses of injection mephentermine sulphate.[Table 3.]

Table 2: Block characteristic

	Group R Mean ± SD	Group Y Mean ± SD	Group B Mean ± S468.1D	R/Y/B** p-value	R/Y* p-value	R/B* p-value	Y/B* p-value
Onset of sensory block (minute)	22.6 ± 5.6	17.9 ± 4.1	13.1 ± 2.9	<0.001	<0.001	<0.001	<0.001
Onset of motor block (minute)	25.7 ± 5.1	21.0 ± 4.6	17.7 ± 3.5	<0.001	0.001	<0.001	0.004
Duration of motor block (minute)	401.6 ± 92.2	535.0 ± 124.1	596.9 ± 149.3	<0.001	<0.001	<0.001	0.057
Duration of sensory block (minute)	468.1± 104.8	645.0 ± 133.6	733.9 ± 166.6	<0.001	<0.001	<0.001	0.017
Duration of analgesia (minute)	571.2 ± 119.6	826.5 ± 158.6	882.7 ± 164.2	<0.001	<0.001	<0.001	0.210

*p value after Mann-Whitney Test between the two groups
**p value after Kruskal-Wallis Test between the three groups

Table 3: Complications

		Group R N	Group R %	Group Y N	Group Y %	Group B N	Group B %
Bradycardia	NO	26	100	23	88.5	25	96.2
	Yes	0	0	3	11.5	1	3.8
Hypotension	NO	26	100	24	92.3	25	96.2
	Yes	0	0	2	7.7	1	3.8

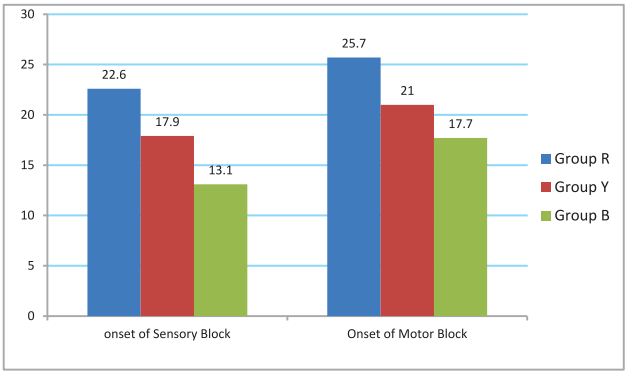

Figure 1: Sensory and motor onset time (minutes)

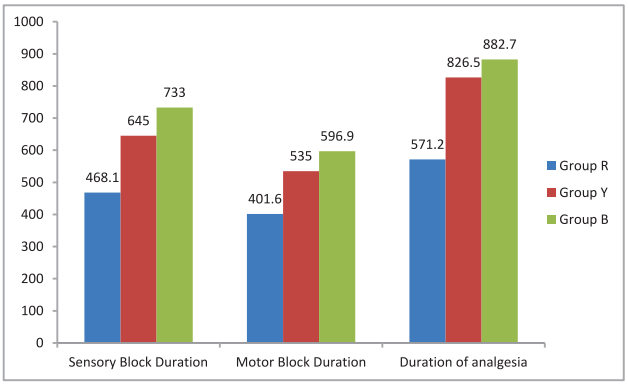

Figure 2: Duration of block

Discussion

Our study demonstrated that addition of Dexmedetomidine (50mcg) to 0.5% 30 ml Ropivacaine in supraclavicular brachial plexus block using ultrasound guided technique resulted in early onset [Figure 1] and prolonged duration of sensory and motor blockade along with prolongation of duration of analgesia postoperatively without significant clinical side effects [Figure 2]. For the supraclavicular brachial plexus block we used 0.5% Ropivacaine. The basis for selecting this concentration was based on the study done by Klein et al., which found that increasing the concentration of Ropivacine from 0.5% to 0.75% did not improve the onset of block, suggesting that the risk of using a higher total dose of local anesthetic may be avoided [6]. Whereas as the study by Hickey and coworker when low concentration of 0.25% ropivacaine was used for subclavian perivascular brachial plexus block for upper limb surgery required frequent analgesic supplement due to low concentration of local anesthetic [7].

In a study of dexmedetomidine as an adjunt to ropivacaine in supraclavicular brachial plexus block conducted by Kathuria et al. using 50mcg dexmedetomidine perineurally and intravenous along with 0.5% ropivacaine found quicker onset of sensory (9.75±4.23 min) and motor block (18.75±6.37 min) and prolonged duration of sen-

sory block (789.45±187.72 min) and motor block (754.60±180.50 min) duration compared to ropivacaine group, which result were similar to our study [4]. Chinappa et al. who performed a study by adding 1mcg/kg of dexmedetomidine to 0.5% ropivacaine found early onset of sensory and motor blockade along with significantly prolonged duration of sensory and motor blockade in the dexmedetomidine group which is similar to our study results [8]. Ammar et al. and Gandhi et al. in their studies also found significant earlier onset of sensory and motor block in the dexmedetomidine group than in bupivacaine group alone [9,10]. Kayguraz et al. in their study that adding dexmedetomidine to 5 % levobupivaaine in brachial plexus block shorten the sensory block onset time, increase motor and sensory block duration with no side effects [11].

The significant prolongation of duration of sensory and motor block in dexmedetomidine group compared to ropivacaine group only was supported by the study conducted by Das et al., Marhofer et al., Zhang et al., and Ozaki et al [3,12,13,14]. Beside efficacy, adverse events and hemodynamic safety should be considered when deciding whether to administer dexmedetomidine perineurally or systemically. In our study no incidence of Bradycardia and Hypotention was found in Group R whereas 3 (11.5%) patient in Group Y and 1 (3.8%) patient of Group B had bradycardia which was treated by giving intravenous atropine 0.6mg . 2 (7.7%) patient of Group Y and 1(3.8%) patient of Group B had hypotention which was corrected by using incremental dose of mephentermine, which is in accordance with the study performed by Kathura et al.; Swami et al.; Esmaoglu et al [14,15,16]. Whereas the dexmedetomidine group had significantly higher incidence of bradycardia and hypotention, according to a study by Bansal et al. Higher incidence of side effects in this study was most likely associated with the use of higher dose of dexmedetomidine (100mcg) [17].

Besides studying the effect of perineural dexmedetomidine (50mcg) to 30 ml 0.5% ropivacaine, we also studied the effect of supplmentation of inravenous dexmedetomidine (50mcg) in a patient who received 30ml of 0.5% ropivacaine in ultrasound guided supraclavicular brachail plexus block and found that it also resulted in early onset of sensory and motor block, prolongation of duration of sensory and motor block, increased duration of analgesia when compared to ropivacaine group alone. When perineural dexmedetomidine group (Group B) was compared with intravenous dexmedetomidine group (Group Y) significant early onset of sensory and motor block, prolonged duration of sensory blockage was found in perineural dexmedetomidine group. However, in context to duration of motor blockade, though the perineural dexmedetomidine group has longer duration of motor block (596.9±149.3 min) compared to intravenous dexmedetomidine group (535.0±124.1), but was not clinically significant. Kathuria et al. in his study, Dexmedetomidine as an adjunt to ropivacaine in supraclavicular brachial plexus block, also found similar finding as our study [4].

Marhoper et al. have demonstrated lesser prolongation of peripheral nerve block with systemic administration of dexmedetomidine compared to perineural dexmedetomidine along with local anesthetic [13]. In contrast similar prolongation of analgesia was found in interscalene block for patient undergoing arthroscopic shoulder surgeries when dexmedetomidine was administered perineurally or systemically [18]. The mechanism of dexmedetomidine analgesia has not been fully clarified, but the main mechanisms might be as follows: (1) peripheral analgesic effect, an analgesic effect produced by inhibiting the transmission of pain signals by inhibiting A-delta and C fibers; (2) central analgesic effect, mainly depolarizes the blue plaque and the descending noradrenergic pathway of the spinal cord to the presynaptic membrane, inhibiting the release of substance P and other nociceptive peptides in the presynaptic membrane and thereby inhibiting the spinal cord via the transmission of angular noxious stimuli, which in turn terminates the signaling of pain; and (3) local analgesic effect, modulation of hyperalgesia by stimulating the a2 receptor [19].

Hence, we speculate that it is primarily the direct peripheral action of dexmedetomidine on the nerve in block that is responsible for its effect rather than due to central action of dexmedetomidine after absorption through block site into systemic circulation resulting in systemic effects. However, dexmedetomidine central effects appear to play some role in prolongation of sensory and motor block duration, as illustrated from our study, which found that 50mcg of intravenous dexmedetomidine significantly prolonged brachial plexus block duration when compared with ropivacaine alone. Moreover, to further understand the processes through which alpha 2 agonists, particularly dexmedetomidine, prolong the action of local anesthetic in peripheral nerve block more detailed studies and research is necessary.

In this study we enrolled patient between age

group 18-60 years and belonging to ASA grade I and II patients only, hence the result may not be applied to older age >60 years and patients with more comorbidities with ASA 3or more. As we were using ultrasound for brachial plexus block the volume of local anesthetic could have been decreased. We did not have the facility of measuring plasma dexmedetomidine level, if it was available it could have further supported to say that dexmedetomidine has a peripheral action rather than centrally mediated.

Conclusion

Thus, from this study, we conclude that in supraclavicular brachial plexus block addition of an alpha 2 agonist dexmedetomidine as adjuvant to local anesthetic 0.5% ropivacaine shortens the sensory and motor block onset time, prolongs both sensory and motor block duration and prolongation of duration of analgesia and is not associated with any major side-effect when compared to 0.5% Ropivacaine without dexmedetomidine and 0.5% Ropivacaine with intravenous dexmedetomidine for supraclavicular brachial plexus block. The action of dexmedetomidine is most probably peripheral than centrally mediated.

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Conflict of interest: None

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